No. 7 — Middle Triassic Nautiloids from Sinai, Egypt, and Israel

By Bernhard Kummel

Triassic formations and faunas from the southern part of Tethys in the Middle East are as yet very incompletely known. Localities with Triassic formations have been recognized to the northeast of the Dead Sea in Jordan, in the Negev of southern Israel and in Sinai, Egypt (Fig. 1). This particular study is concerned with a small fauna of nautiloids from Araif-el-Naga, Sinai, and the Makhtesh [= Wadi] Ramon, Israel. Some of the Sinai specimens are those recorded but not described by Awad (1945) and which are deposited in the British Museum (Natural History). These specimens were obtained on loan through the courtesy of Dr. M. K. Howarth of that institution. A second collection consisting of many, but generally poorly preserved, specimens from Araif-el-Naga, Sinai, and from Makhtesh Ramon, Israel, have been presented to the Museum of Comparative Zoology by the Iraq Petroleum Company, Ltd., through the courtesy of Dr. R. G. S. Hudson. Finally, a third group of five specimens from the Makhtesh Ramon was obtained on exchange with Mr. A. Parness of the Israel Geological Survey.

The existence of Triassic strata in Israel was first discovered by the geologist of the Iraq Petroleum Company whose work was partially published by Shaw (1947). These Triassic strata were found in the Makhtesh Ramon where they crop out in the center of a large anticlinal structure. Brief notes on some vertebrate fossils from these exposures have been published by Swinton (1952) and Brotzen (1955). Recently, Brotzen (1957) has described more vertebrate remains plus some pelecypods from Makhtesh Ramon. A significant part of this paper (Brotzen, 1957) is a clear discussion of the stratigraphy of the Triassic strata exposed in the Makhtesh Ramon with data on the distribution of fossils in this section. Brotzen's stratigraphic section of the Triassic formations exposed in the Makhtesh Ramon is as follows:

Member "D", the *Ceratites* beds		
30.	Limestone and marls with *Ceratites* (*Ceratites*, zone 5)	2.0 m
29.	Limestone and marls with *Ceratites* (*Ceratites* zone 4)	5.8
28.	Light brown marls and limestones with *Ceratites*, *Arcestes*, *Joannites*, *Placodus*, *Nothosaurus* (Ceratites, zone 3)	5.0
27.	Hard limestone layers	2.4

26. Limestone and marls with *Paraceratites* spp., abundant nautiloids, pelecypods (*Ceratites* zone 2) 13.0
25. Terebratula layer 0.10-0.40
24. Sandy limestone, bluish, and shales with bone beds, *Paraceratites*, *Psephosaurus picardi* (Brotzen, 1957) *Nothosaurus*, *Myophoria laevigata* Goldfuss, *Mysidia*, *Lithophagoides*, *Coenothyris vulgaris* Schlotheim, *Pleuromya elongata* Schlotheim, aff. *Homomya* (*Anoplophora*) *fassaensis* Wissmann, nautiloids (*Ceratites* zone 1) 6.0
23. Sandy and shaly layers 1.8

Member "C", the reef beds

22. Sandstone 1.1
21. Tan, pink, and blue shale with fish remains, bones, *Lingula* 2.4
20. Ash 1.2
19. Brown and gray laminated shale, sandy at the top; fish teeth, plant remains 16.6

Member "B", the *Beneckeia* beds

18. Marls, light yellow and brown. *Beneckeia* sp. 3, *Myalina* spp., bones 6.0 m.
17. Sandstone 0.3
16. Shale, dark-green, *Beneckeia* sp. 3, *Beneckeia* sp. 2, *Myalina* spp., bones 5.0
15. Shales with sandy layers containing *Beneckeia* sp. 3, *Beneckeia* sp. 2, *Myalina beneckei*, *Myalina* spp., bones 2.5
14. Porphyritic sill (locally)
13. *Myalina* beds with bones 0.3
12. Shales, greenish, *Psephosaurus* beds 6.0
11. *Myalina* limestone 0.2
10. Marls with rich fauna, *Beneckeia* sp. 2, *Myophoria* sp., brachiopods, bones 2.0
9. Sandstone with trails 0.3
8. Shales with *Myalina*, *Myophoria*, bones 4.0
7. Sandstone with *Beneckeia*, sp. 1 0.3
6. Brownish shales 1.5

Member "A", wood-bearing beds

5. Dark grey, hard, igneous rocks, probably of felsitic affinities—locally absent
4. Sandstone 2.5
3. Green-grey, also tan, laminated shale, *Lingula* 4.3
2. Brown sandstone, interbedded with grey shales; *Lingula*, fish teeth, plant remains, bone fragments 3.2
1. Grey laminated medium hard shale, with badly preserved fossils 6.4

As can be seen from this section ammonoids are well represented and a monograph on a part of this fauna by Mr. A. Parness is now in preparation. Preliminary analysis of the fauna from the Makhtesh Ramon enabled Brotzen to conclude

that *Ceratites* zones 3 to 5 of member "D" were most likely lower Ladinian in age; that member "C" and *Ceratites* zones 1 to 2

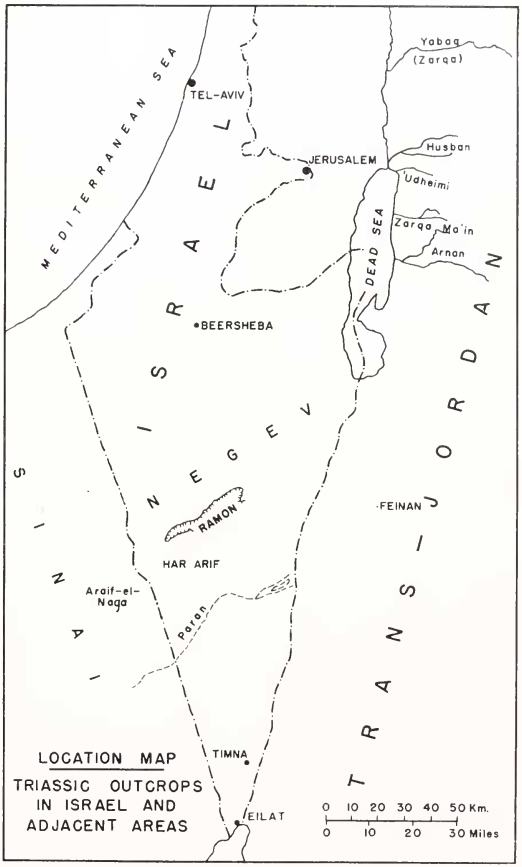

Figure 1. Location map of Triassic outcrops in Israel and adjacent areas. A glossary of the Hebrew, Arabic, and English names most commonly used on maps of this area can be found in Ball and Ball (1953, p. 111).

were Anisian in age (Paraceratitan age of Spath); that the *Beneckeia* zones were lower Anisian and possibly also in part uppermost Scythian in age; and finally that Member "A" was Scythian for which, however, there is no paleontological evidence. These age assignments appear to be correct. Nautiloids are present in member "B" (the *Beneckeia* beds) and in member "D" (the *Ceratites* beds). The only nautiloids available in the present collection from member "C" (*Beneckeia* beds) is *Indonautilus awadi* n. sp. Member "D" (the *Ceratites* beds) contains *Germanonautilus bidorsatus* (Schlotheim), *G. salinarius* (Mojsisovics), *Mojsvarocceras* cf. *marloti* (Mojsisovics), and *M.* sp. indet.

The only Triassic formations known in Egypt crop out in the Gebel Araif-el-Naga, Sinai, in the center of a large dome. A brief study on the stratigraphy and fossils from these Triassic formations has been published by Awad (1945). The oldest strata exposed in the Araif-el-Naga dome are vari-colored unfossiliferous sandstones of unknown thickness. These strata are overlain by 20-25 meters of thin-bedded limestones, sandstones, shales, gypsums, and marls. Within this series there are a number of fossiliferous bands from which Awad (1945) identified the following species:

Enantiostreon difformis (Schlotheim)
Enantiostreon spondyloides (Schlotheim)
Myophoriopsis (*Pseudocorbula*) *subundata* (v. Shauroth)
Pecten (*Pseudomonotis*) *inequistriatus* Münster
Pecten (*Syncloncma*) *discites* Schlotheim
Plicatula (*Pseudoplacunopsis*) *fissistriata* Winkler
Modiola raibliana Bittner
Schafhautlia sp.
Omphaloptycha gregaria Schlotheim
Nucula subequlatera Schafhautl
Leda elliptica (Goldfuss)
Pteria aff. *cassiana* Bittner
Myophoria elegans Dunker
Myophoria cardissoides (Schlotheim)
Myophoria germanica Hohenstein
Myophoria coxi Awad
Myophoria laevigata (Zieten)
Anodontophora munsteri Wissmann

A unit of approximately five meters in thickness in the mid part of this 20-25 m. unit contains, according to Awad, nu-

merous nautiloids and ammonoids. Several specimens of cephalopods were submitted by Awad to L. F. Spath who reported (in Awad, p. 425) that the majority of the ammonites were *Ceratites*, most comparable to the group of *C. flexuosus* and probably deserving a separate subgeneric name. Spath likewise considered these ammonoids as indicating a lower Ladinian age. A fragment of a *Beneckeia* was also recognized by Spath in Awad's collection. The writer's specimens of nautiloids from the Sinai presumably came from this fossiliferous unit and include *Germanonautilus* cf. *adrena* (Fritsch), *Mojsvarroceras* cf. *marloti* (Mojsisovics), and *Indonautilus awadi* n. sp.

Above this fossiliferous unit there are 25 meters of greenish and yellowish clays, shales, and marls with thin beds of limestone. From this unit Awad (1945) recognized *Pecten* (*Syncloncma*) *discites* Schlotheim, *Hoernesia* cf. *hebanensis* Cox, *Omphaloptycha gregaria* Schlotheim, and fragments of nautiloids. The uppermost unit of the Triassic sequence consists of 50-60 meters of massive, hard, limestone, probably dolomitic, devoid of fossils.

Awad is not clear as to the stratigraphic position of his specimen of *Beneckeia* identified by Spath, but it seems doubtful that it is from the same unit as his *Ceratites*. As noted above, Spath came to the conclusion that the ammonites indicated these deposits were lower Ladinian in age, but Awad on the basis of his study of the remainder of the fauna favored a lower Anisian age. This conflict of opinions cannot be adjusted until the position of *Beneckeia* relative to the other ammonoids is precisely known. On this question Brotzen (1957, p. 207) assumed that equivalents of his *Beneckeia* beds must be present in the Araif-el-Naga dome and that the main fossiliferous beds were equivalent to his member "D" (the *Ceratites* beds).

The few other areas of Triassic exposures in the Middle East are either poor or totally lacking in cephalopods. The only other area of Triassic exposures in Israel is at Har Arif, 20 km. southwest of Makhtesh Ramon, where Bentor and Vroman (1952) identified a sequence comparable in lithology and fossil content to that of Makhtesh Ramon but no details are available.

Cox (1932) has recognized a Lower Triassic fauna from shale and sandstone beds exposed along the eastern shore of the Dead Sea in the neighborhood of Wadi Zarqa Mai'n (Fig. 1). This fauna includes *Pseudomonotis* (*Claraia*) *aurita* (Hauer), *My-*

ophoria laevigata (Zieten), *Myophoria praecorbicularis* Bittner, *Anodontophora fassaensis* (Wissmann), and *Lingula tenuissima* Bronn. Another Triassic fauna from Jordan is known from the region of Wadi Husban at the northeast corner of the Dead Sea (Fig. 1). In this fauna Cox (1932) recognized a large number of species of pelecypods, a few species of brachiopods and gastropods, one nautiloid (*Pleuronautilus* sp.) and one ammonoid (*Beneckeia* sp.). In his first study of this fauna, Cox (1924) concluded that it was most probably Karnian in age. Determination of the age of this fauna was complicated by the mixture of Alpine and Germanic species. In a subsequent study based on additional material from the same localities Cox (1932) withdrew his conclusion as to the age of the fauna and left the problem of age open. Part of the pelecypod fauna appears to indicate an Upper Triassic age, but these forms are associated with the ammonoid *Beneckeia* sp. which suggests a Lower Muschelkalk (Anisian age) as do some of the brachiopod and pelecypod species.

These few areas of Triassic formations in Jordan, Israel, and Sinai, in their stratigraphy and facies development, indicate approximation to the southern shores of Tethys. Recently Avnimelech (1959) has reported on a deep well drilled at Kfar Yeruham (Rekhme) situated approximately 30 km. south of Beersheba and 40 km. north of the Ramon anticline. The cuttings from 2217 to 2760 m. consist of black bituminous-pyritic shale and coarse, granulous detrital limestone. The samples from 2650 m. included an ammonite identified by Avnimelech as the inner whorls of a *Beneckeia;* in addition this sample contained *Myophoria elegans* or *postera* and *Diplasma ecki* indicating an Anisian age. Samples from 2235-2576 m. possibly contain *Halobia*, suggesting an Upper Triassic age (Karnian). The lithology of the Triassic strata in this bore hole indicates a more pelagic facies than encountered in the outcrop area of Triassic formations from the Dead Sea to the Sinai. On the basis of this data, Avnimelech (1959, p. 174) has constructed a highly interesting paleogeographic map for the Middle Triassic. Following along the southern regions of Tethys, the next area of Triassic exposures to the east is in central Saudi Arabia (Arkell, et al., 1952; Steineke, et al., 1958); to the west the first Triassic exposures are at Azizia 40 km. south of Tripoli, Libya (Coggi, 1940).

SYSTEMATIC DESCRIPTIONS

Family TAINOCERATIDAE Hyatt, 1883

Genus GERMANONAUTILUS Mojsisovics, 1902

Type species. Nautilus bidorsatus Schlotheim, 1832.

The largest number of specimens in this collection of nautiloids are species of the genus *Germanonautilus*. Unfortunately, they are generally the most poorly preserved and only a small series of them are sufficiently well preserved to warrant detailed discussion. Specimens from the Middle Triassic strata at Makhtesh Ramon, Israel, can be assigned to *Germanonautilus bidorsatus* and *G. salinarius*. A large living chamber with only two or three camerae of the phragmocone appears to belong to, or is at least closely related to, *Germanonautilus advena* Fritsch (1902, pl. 2, figs. 10, 11). This particular species of *Germanonautilus* has the most depressed whorl section of all the species assigned to this genus and for this reason is quite distinctive.

Fourteen species of *Germanonautilus* are known to date ranging from the Scythian into the Karnian. The genus is particularly widespread in the Muschelkalk facies of Germany.

GERMANONAUTILUS SALINARIUS (Mojsisovics)

Plate 3, figures 1, 2

Nautilus salinarius Mojsisovics, 1882, p. 282, pl. 91, fig. 3; Hauer, 1887, p. 13; Hauer, 1892, p. 253; Hauer, 1896, p. 243; Diener, 1900, p. 36.

Nautilus f. indet. Mojsisovics, 1882, p. 282, pl. 92, figs. 1a-b.

Germanonautilus cf. *salinarius*, Diener, 1907, pp. 29-30, pl. 3, fig. 1.

Germanonautilus salinarius, Diener, 1915, p. 330; Alma, 1926, p. 114; Kummel, 1953, p. 28, fig. 9 A.

Germanonautilus sp. ind. aff. *salinario*, Diener, 1915, p. 330 (for *Nautilus* f. indet. Mojsisovics, 1882, p. 282, pl. 92, figs. 1a-b).

Two of the specimens from Makhtesh Ramon can be assigned to this common Tethyan species of *Germanonautilus*. The larger and best preserved specimen measures 91 mm. in diameter, 66.7 mm. for the width of the last whorl, 53.0 mm. for the height of the last whorl, and the umbilicus is 14.0 mm. in diameter. The second specimen is a phragmocone of 68 mm. in diameter but not well preserved.

The conch is moderately involute with a robust, subquadrate whorl section. The whorl sides are slightly arched and converge toward a broad, flattened venter. The ventral and umbilical

shoulders are well rounded. The umbilical wall is broadly arched and slopes at a fairly steep angle to the umbilical seam. The suture is simple, being characterized by shallow ventral and lateral lobes. The siphuncle is subcentral, being closer to the dorsum than to the venter.

Remarks. Of all the specimens which have been assigned to this species that figured by Mojsisovics (1882, pl. 92, figs. 1a-b) is most similar to the Israeli specimens recorded here. The type specimen of *G. salinarius* (Mojsisovics, 1882, pl. 91, figs. 3a-b) is more quadrate in whorl section, the whorl sides converging very gently toward the broad venter. Mojsisovics' other specimen and the Israeli specimen display more convergence of the whorl sides but this is not considered to be of specific importance, the difference being much too slight and only that to be expected. The specimen from the Himalayas described by Diener (1907) is also nearly identical to the Israeli specimens. Diener (1907) makes note of the presence of an annular lobe on his Himalayan specimen, a feature which is also present on the Israeli specimen, even though weakly. This feature, however, was not observable on the Alpine specimens.

Occurrence. Middle Triassic, *Ceratites* beds, Makhtesh Ramon, Israel.

Repository. MCZ 6090 (Pl. 3, figs. 1, 2); MCZ 6091, unfigured specimen

Germanonautilus bidorsatus (Schlotheim)

Plate 3, figures 3, 4

Nautilus bidorsatus Schlotheim, 1832, p. 82, pl. 31, figs. 2a-b (*non* 2c); Bronn, 1837, p. 177, pl. 11, fig. 21; Mallada, 1880, p. 243, pl. 1, figs. 1-2; Rassmuss, 1915, p. 286.

Temnochcilus bidorsatus, Foord, 1891, p. 160; Franz, 1903, p. 494.

Germanonautilus bidorsatus, Mojsisovics, 1902, p. 235; Diener, 1915, p. 329; Kieslinger, 1925, p. 120, text-fig. 8; Schmidt, 1928, p. 285; text-figs. 788, 790; Kutassy, 1933, p. 712; Kummel, 1953, p. 28.

This well known species of *Germanonautilus* is represented by a well preserved partial phragmocone of slightly less than one-half volution. The ventral and umbilical shoulders of the specimen are rounded, the whorl section being broader than high. The venter is broadly sulcate and the umbilical walls arched. The published illustrations of *G. bidorsatus* leave much to be desired and in the identification of this specimen the writer was greatly aided by a splendid collection of specimens from the Muschelkalk

of Germany in the Museum of Comparative Zoology. The Israeli specimen, as far as can be told, is nearly identical to the specimens from Germany and should be assigned to *G. bidorsatus*. In addition to this specimen there is also a very poorly preserved complete phragmocone.

Occurrence. Middle Triassic *Ceratites* Beds, Makhtesh Ramon, Israel.

Repository. MCZ 6092 (Pl. 3, figs. 3, 4); MCZ 6093, unfigured specimen.

Germanonautilus cf. advena (Fritsch)

Monilifer (= *Germanonautilus*) *advena* Fritsch, 1902, pl. 2, figs. 10-11.
Germanonautilus advena (Fritsch), Kummel, 1953, p. 28.

A poorly preserved specimen consisting of the living chamber and three camerae deserves at least a brief mention due to its extremely depressed whorl section. Whorl sections such as this are not common among the known species of *Germanonautilus* and is characteristic only of *G. advena* (Fritsch). The whorl section of the present specimen measures approximately 90 mm. in width and 50 mm. in height. Measurements of Fritsch's figured specimen (Fritsch, 1902, pl. 2, fig. 10) yield 70 mm. for the width of the whorl and 38 mm. for the height. The percentage of width to height is approximately the same. The present specimen differs from *G. advena* mainly in the less convergent aspect of the whorl sides and the broadly arched umbilical slope rather than a roughly straight slope as in *G. advena*.

Occurrence. Middle Triassic formation at Araif-el-Naga, Sinai, Egypt.

Repository. MCZ 6094.

Genus Mojsvaroceras Hyatt, 1883

Type species. Temnocheilus neumayri Mojsisovics, 1882

Mojsvaroceras cf. morloti (Mojsisovics)

Plate 1, figures 6-8; plate 2, figures 1-6

Temnocheilus morloti Mojsisovics, 1882, p. 268, pl. 88, fig. 3; Hauer, 1896, p. 248.
Mojsvaroceras morloti, Mojsisovics, 1902, p. 233; Diener, 1915, p. 334; Gugenberger, 1927, p. 102, Kutassy, 1933, p. 718.
Metacoceras (*Mojsvaroceras*) *morloti*, Kummel, 1953, p. 21.

Several specimens of variable preservation that appear to be conspecific are in the collections from Makhtesh Ramon, Israel, and Araif-el-Naga, Sinai, Egypt. The best preserved example is a phragmocone illustrated on Plate 2, figures 1, 2. It measures 67.8 mm. in diameter, 30.7 mm. in height of last whorl, 40 mm. in width of the last whorl, and the umbilicus measures 18 mm. in diameter. The largest example (MCZ 6097), also a phragmocone, is weathered and generally not as well preserved but it measures 73.5 mm. in diameter, 51.3 mm. for the width of the last whorl, 35.0 mm. for the height of the last whorl, and 21.3 mm. for the diameter of the umbilicus. The whorl section is subquadrate with a broad, low arched venter, rounded ventral shoulders, flattened lateral areas, rounded umbilical shoulders and a fairly broad sloping umbilical wall. The suture consists of shallow ventral and lateral lobes. The phragmocone is smooth, except for fairly large low nodes on the umbilical shoulder. There appear to be 10 such nodes on this specimen.

A smaller conspecific specimen from the same locality and horizon as that described above is illustrated on Plate 2, figures 3-6 (MCZ 6096). This specimen measures 37.0 mm. in diameter, 24.6 mm. in width of the last whorl, 18 mm. in height of last whorl, and 8.5 mm. for the diameter of the umbilicus. The whorl section is more trapezoidal in outline than the larger more mature specimen, with the lateral areas distinctly converging toward the venter. Likewise, the ventral and lateral lobes are slightly deeper and there is an annular lobe. The small umbilicus is subcentral in position, that is, closer to the dorsum than the venter. The ventral shoulders are smoothly rounded but the umbilical shoulders are sharply rounded. The first volution of this specimen is illustrated on Plate 2, figure 6 and measures 25.5 mm. in diameter. At the end of the first volution the whorl section measures 17.4 mm. in width, 12 mm. in height, and the umbilicus is 5 mm. in diameter. The ventral half of the first half whorl is broken so that a portion of the siphuncle is exposed. This is typically beaded, composed of slender cylindrical sections with marked constrictions between each of the segments. The shell is preserved on parts of this small specimen and has rather marked and coarse growth lines that inscribe a deep hyponomic sinus on the venter. The nodes which are so conspicuous on the larger specimens are absent on the smaller specimen.

The specimens discussed above came from Middle Triassic strata at Makhtesh Ramon, Israel. An additional small, immature specimen from Araif-el-Naga is tentatively considered to be conspecific with this species and is illustrated on Plate 1, figures 6-8. This specimen measures 27.5 mm. in diameter, 20 mm. in the width of the last whorl, 14 mm. in the height of the last whorl, and 6.3 mm. in diameter of the umbilicus. The shape and general character of the conch is similar to that of the specimen described above and illustrated on Plate 2, figures 3-6, except that the position of the siphuncle is central and the annular lobe is only weakly developed. More of the shell is preserved on this specimen and it bears on the most adoral part of the outer volution fine growth lines with a deep tongue-shaped sinus on the venter which in places is also reflected on the internal mold. The shell on the earliest volution has a fine reticulate ornamentation (Pl. 1, fig. 7).

Remarks. Evolute nautiloids with subquadrate whorl sections and nodes on either or both of the shoulders form one of the most common and widespread types found in late Paleozoic and Triassic formations. The late Paleozoic species comprise the genus *Metacoceras* for which about 50 species have been described. The Triassic representatives are nearly identical to the late Paleozoic *Metacoceras* and differ mainly in a slightly greater involution and the presence of an annular lobe. Because of this close relationship, *Mojsvarocceras* has been considered to be a subgenus of *Metacoceras* (Kummel, 1953, pp. 19-23). At present there are 18 described species of the subgenus *Mojsvarocceras* known from the region of the Tethyan geosyncline, northern Siberia, and western United States (Idaho and California). Stratigraphically, two of these species are known from Scythian strata, 12 from the Anisian, one from the Ladinian, and three from the Karnian. The species of *Mojsvarocceras* are differentiated on slight differences in the shape of the whorl section and the disposition of the nodes. As is typical of Mesozoic nautiloid faunas, large samples of any of these species are not known or available and the range of intra-specific variation poorly understood. For this reason the specimens described here are not given a new specific name but rather assigned to an already described species which it most closely resembles. The type of *Mojsvarocceras morloti* (Mojsisovics, 1882, p. 268, pl. 88, fig. 3) differs from the Middle East specimens described here merely in the greater breadth of the outer whorl but otherwise is nearly identical.

Occurrence. Plesiotypes (Pl. 2, figs. 1-6) and unfigured specimen from Middle Triassic formations at Makhtesh Ramon, Israel; Plesiotype (Pl. 1, figs. 6-8) from Middle Triassic at Araif-el-Naga, Sinai, Egypt.

Repository. Plesiotype (Pl. 2, figs. 1, 2) MCZ 6095; Plesiotype (Pl. 2, figs. 3-6) MCZ 6096; Plesiotype (Pl. 1, figs. 6-8) BM (NH) C 55325, unfigured specimens MCZ 6097, MCZ 6098.

Mojsvaroceras n. sp. indet.

Plate 2, figures 7, 8; plate 4, figures 3, 4

A single, incomplete phragmocone from Makhtesh Ramon, Israel, is clearly a species of *Mojsvaroceras* but quite different from *Mojsvaroceras* cf. *morloti* which is also recorded from this area. It is only because of the incompleteness of the specimen that the author refrains from proposing a new name.

The specimen measures 67 mm. in diameter and consists of only a half volution of the conch, all septate. The cross-section of the most adoral part of outer whorl is subquadrate, having subparallel lateral areas and a broadly arched venter. Both the ventral and umbilical shoulders are rounded and the umbilical wall is broadly arched and nearly vertical. The quadrate aspect of the whorl section is apparent only on the most adoral portion of the specimen; prior to this the whorls are depressed, elliptical in shape. The innermost whorls visible are almost circular in cross-section.

The whorl sides bear large blunt nodes along the ventral shoulder which are slightly elongated in a dorsoventral direction. On the earlier volutions where the whorl section is depressed and elliptical in cross-section, the large nodes are at the mid-region on the flanks at a position where both the umbilical and ventral shoulders begin. As the whorl section becomes more quadrate in cross-section the nodes shift toward the ventral shoulders.

The siphuncle is in an extreme dorsal position and measures 3.5 mm. in diameter.

The suture is of a very simple pattern having a broad, shallow lobe on the flanks and passing over the arched venter in nearly a straight line.

Two small, fragmentary specimens from Araif-el-Naga, Sinai, are believed to be conspecific with the larger form from Makhtesh

Ramon, Israel. The better preserved of these specimens is illustrated on Plate 2, figures 7, 8. This specimen consists of slightly more than one-third of a volution of phragmocone. The most adoral camerae are depressed, elliptical in cross-section, having a broadly arched venter, arched whorl sides and umbilical wall. Blunt nodes are present on the ventral shoulder. The suture has a very slight lateral lobe and passes over the venter forming a very slight ventral saddle. The siphuncle is subcentral in position. This small specimen differs from the larger example only in the lesser prominence of the lateral nodes.

Remarks. The changes in the cross-section of the whorls during the ontogeny of this species and the large lateral nodes are the distinctive features that separate this species from all others of *Mojsvaroceras* that have been recorded to date. Of the seventeen species of *Mojsvaroceras*, fourteen are confined to Tethys, and of these twelve are known only from the general area of the Alps and two from the Himalayas. Of all these species only *M. binodosum* (Hauer) has at least some resemblance in gross conch features to *Mojsvaroceras* n. sp. indet. but that species as the name implies has nodes both on the ventral and umbilical shoulders. Likewise the nodes seem to disappear adorally and are absent on the living chamber. The other alpine species differ even more in whorl shape and pattern of ornamentation. There is likewise no resemblance to *M. nivicola* Diener or *M. kagae* Diener from Anisian strata of the Himalayas.

Occurrence. Middle Triassic formations at Araif-el-Naga, Sinai, Egypt, and from *Ceratites* beds (probably higher part) at Makhtesh Ramon, Israel.

Repository. Pl. 4, figs. 3, 4, MCZ 6099; Pl. 2, figs. 7, 8, MCZ 6100.

Family LIROCERATIDAE Miller and Youngquist, 1949

Genus INDONAUTILUS Mojsisovics, 1902

Type species. Nautilus kraffti Mojsisovics, 1896

Indonautilus is one of a large group of Triassic nautiloid genera which are either monotypic or have few species. The genotype is known from a single specimen from the *Halorites* limestone (Norian) at Bambanag in the Himalayas. In addition, Jaworski (1915, pp. 131-132) has assigned to the type species a specimen from Norian rocks on the Island of Misol. A new species of *Indonautilus* is now recognized among the collec-

tions from the Sinai and Israel. *Indonautilus* is characterized by its extremely involute conch, whorl section with sharply to acutely rounded ventral shoulders, broadly flattened venter, and absence of an annular lobe. On the basis of this morphological framework it appears most likely that *Indonautilus* is closely related to and derived from *Paranautilus*.

Indonautilus awadi n. sp.

Plate 1, figures 1-5; plate 2, figures 9, 10; plate 4, figures 1, 2.

Four specimens from Araif-el-Naga, Sinai, and one from Makhtesh Ramon are available for study. The holotype specimen (BM (NH) C 55324, Pl. 1, figs. 1-3) measures 72.0 mm. in diameter and is all phragmocone, as are all the specimens in the collection. The holotype has a tightly coiled conch with no umbilical opening, the whorl section is subquadrate measuring 45 mm. in height and 42 mm. in width. The flanks converge slightly toward the venter and are only weakly arched; the venter is broad and flattened. The ventral shoulders are sharply rounded. The suture forms a broad shallow ventral lobe, a lateral lobe that occupies the lower two-thirds of the flanks and a broad low saddle that occupies the upper third of the flanks. There does not appear to be any annular lobe. The siphuncle is slightly dorsal of a central position.

The specimen illustrated on Plate 1, figures 4, 5 is thought also to be a representative of this species. The position of the siphuncle, degree of involution, degree of compression of the whorl section and the suture suggest this relationship. At first glance the most noteworthy difference is the lack of sharply rounded ventral shoulders. However, the specimen is an internal mold (all phragmocone) that has undergone much weathering which masks the details, namely the more rounding of the whorl section especially in the region of the venter. This particular specimen appears to be identical with that figured by Awad (1945, pl. 3, figs. 22a, b) from the same horizon and locality. The main features of the conch of immature forms are illustrated by the specimen shown on Plate 2, figures 9-10.

The specimen from Makhtesh Ramon, Israel (Pl. 4, figs. 1, 2), measures 80 mm. in diameter, approximately 64 mm. for the width of the last whorl, and 53 mm. for the height of the last whorl. It is believed to be conspecific with the specimen from

Sinai even though it differs in some features. For one thing the ventral shoulders of the Israeli specimen are not so sharply rounded. The venter also is slightly arched rather than being flattened. Another striking difference is the great width of the most adoral camerae; however, the great expansion of the whorl width is developed by the most adoral six camerae. Prior to these last six camerae, the conch dimensions are comparable to those on the holotype. In other features such as the degree of involution, position of the siphuncle, and the suture, the Israeli specimen is nearly identical to those from Sinai.

Remarks. Indonautilus awadi is characterized by its occluded conch, sharply rounded ventral shoulders, and its suture. *Indonautilus kraffti* is slightly more evolute and the suture is not quite so sinuous. The two specimens of the type species that have been recorded to date are likewise considerably smaller than the specimens from the Sinai and Israel.

Occurrence. Middle Triassic at Araif-el-Naga, Sinai, Egypt, and from *Beneckeia* beds at Makhtesh Ramon, Israel.

Repository. Holotype (Pl. 1, figs. 1-3) BM (NH) C 55324; paratype (Pl. 1, figs. 4-5) BM (NH) C 55321; paratype (Pl. 2, figs. 9-10) BM (NH) C 55322; unfigured paratype BM (NH) C 55323; paratype from Israel (Pl. 4, figs. 1, 2) MCZ 6101.

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